

**TECHNICAL REPORT
NATICK/TR-82-044**

**A MICROBIOLOGICAL QUALITY
ASSURANCE PROGRAM
FOR THE CENTRAL
PRODUCTION FACILITY AT
F. E. WARREN AFB**

**BY
GERALD SILVERMAN**

MARCH 1982

**UNITED STATES ARMY NATICK
RESEARCH & DEVELOPMENT LABORATORIES
NATICK, MASSACHUSETTS 01760**



APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

**SCIENCE AND ADVANCED TECHNOLOGY LABORATORY
SATL**

Approved for public release; distribution unlimited.

Citation of trade names in this report does not constitute an official indorsement or approval of the use of such items.

Destroy this report when no longer needed. Do not return it to the originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NATICK/TR-82/044	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A MICROBIOLOGICAL QUALITY ASSURANCE PROGRAM FOR THE CENTRAL PRODUCTION FACILITY AT F.E. WARREN AFB		5. TYPE OF REPORT & PERIOD COVERED Technical
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Gerald Silverman		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Natick Research and Development Laboratories Science and Advanced Technology Laboratory Natick, Massachusetts 01760		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1L162724AH99BB096
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Natick Research and Development Laboratories DRDNA-YMM Natick, Massachusetts 01760		12. REPORT DATE March 1982
		13. NUMBER OF PAGES 17
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) COOK-FREEZE QUALITY ASSURANCE PROGRAM MICROBIOLOGY F.E. WARREN AFB CENTRAL PREPARATION FACILITY SANITATION		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A microbiological Quality Assurance Program, has been designed specifically for the F.E. Warren AF Central Production Facility for the production of precooked frozen items. These items must meet microbiological constraints imposed by Strategic Air Command before they can be released for consumption. The main elements in this program are (1) end product analysis, (2) time-temperature monitoring, and (3) control of raw and commercially processed food sources. The program is designed to be conducted by a Quality Inspection Specialist aided, on a limited basis, by selected food production personnel.		

PREFACE

This Quality Assurance Program (QAP) was designed for the unique operation at the F.E. Warren AFB and to satisfy the following constraints.

- One Quality Inspection Specialist (QIS) would be available for conducting microbiological analysis and to coordinate the QAP.
- Stabilization of the production facility in regards to operational procedures and efficiency would be achieved by NLABS personnel.
- Key personnel at the Central Production Facility would be able to participate in this program in coordination with the Quality Inspection Specialist.

The objectives for this program were essentially achieved in FY81-82, for the requirements for the task USAF 4-2, Air Force Missile Site Feeding System and the QAP described in this document has been tested while completing task AF 80-8, Support to AF Missile Site Feeding, and found to be effective.

Dr. E. Ross contributed to this QAP by determining the number of isolates required for the enumeration of coliforms and *Escherichia coli*. Mr. J. Gladstone collaborated in the establishment of processing constraints and also in the evaluation of their effectiveness.

The success of this Microbiological Quality Assurance Program is also due to Dr. R.D. Davis, University of Massachusetts, and Mr. R. Bustead, Mr. H. Kirejczyk and Dr. D.P. Leitch of ORSA, NLABS for designing and implementing a production and inventory system, and also to Ms. V. Loveridge, FEL, NLABS for developing effective production guides.

TABLE OF CONTENTS

	Page
Preface	1
Introduction	5
Procedures	5
Conclusions	13
Recommendations	13
Supplemental References	14
Appendix A. Notes for the Procedures for Analyzing Food Samples	15
Figure and Tables	
Figure 1. Microbiological Analysis	8
Table 1. Microbiological Limits for Precooked Frozen Foods	7
Table 2. Specific and General Monitoring Elements Used in Surveillance	10

A MICROBIOLOGICAL QUALITY ASSURANCE PROGRAM FOR THE CENTRAL PRODUCTION FACILITY AT F.E. WARREN AFB

INTRODUCTION

With the conversion of the Central Production Facility from a produce-to-order production system to a produce-to-inventory production system the quantity of each menu item being processed at any given time has increased greatly. Rejection for either microbiological or quality reasons will consequently result in considerably greater economic losses and may prevent the completion of an order.

The objective of this Quality Assurance Program (QAP) is to minimize rejections due to nonconformance with the requirements of SACR 146-1¹ on precooked, frozen meals by:

- Controlling temperature-time variables during processing.
- Using only ingredients obtained from reliable sources.
- Maintaining a sufficiently high standard of sanitation for equipment and personnel.
- Conducting microbiological analysis of the processed item for safety and to serve as a measure of the effectiveness of the QA program.

In addition to microbiological constraints, the QA program will also verify, using a technical evaluation panel, that processed menu items are of an acceptable sensory quality.

This QAP has increased the complexity of monitoring since the emphasis is no longer mainly upon end-product testing but upon the prevention of production errors and ingredient control. This program, though, could not be initiated until production and inventory modifications resulted in fewer items being produced daily so that the microbiological testing burden could be decreased and monitoring activities increased. Stabilization of production procedures also contributed to the success of the QAP by insuring that any processing constraints could be effectively monitored.

PROCEDURES

I. MICROBIOLOGY

A. Sampling

1. The size of a unit of sampling, a lot, will be determined by the QIS and NLABS personnel for each menu item according to the following guidelines:

¹Strategic Air Command Regulation, SACR 146-1 Food Service, Frozen Foil Pack Meal Program, 20 February 1974.

a. Items will be assigned to two groups:

(1) Class I. Those items that consistently satisfy microbiological requirements. For production runs not exceeding 3600 foils then one composite sample (see I.B.1 below) is taken. For more than 3600 foils the production run is divided in two or more increments, each not to exceed 2000 foils, and a composite sample obtained for each increment.

(2) Class II. Those items which have been periodically rejected. A composite sample will be obtained for each 1000 foils.

b. The classification of menu items are given below. An item may be reassigned to either group by the Quality Inspection Specialist.

Menu Item						
● Class I	22	32	41	48	57	74
	28	33	42	49	58	76
	29	35	44	53	70	90
	30	37	45	54	72	
	31	40	46	55	73	
● Class II	23	91				
	24					
	26					

2. If there is an extended interruption in production then samples prior to and after the interruption will be taken and analyzed separately.

3. If most or all of the ingredients of an item are processed in a kettle, then each kettle should constitute a lot.

4. When large quantities of a product are being formulated and processed for an extended period of time then the lot size can be established by the QIS by dividing the estimated production period into increments, none to exceed one hour.

B. Analysis

1. Five foils will be obtained from each lot and a composite sample will be derived for analysis in accordance SACR 146-1².

² Ibid.

2. Procedure

a. The procedure for analyzing food samples is illustrated in Figure 1. Comments or further details of the procedures are numbered in brackets in Figure 1 and discussed in Appendix A. The procedure is designed to conform to that of SAC Regulation 146-1³ in confirming the presence of coliform and of *Escherichia coli* isolates.

b. Requirements

(1) Requirements of SACR 146-1⁴ for the analysis of the composite sample are:

Aerobic Plate Count — not to exceed 100,000 CFU/g

Coliform — not to exceed 100 CFU/g

Escherichia coli — none per gram

(2) If the composite sample fails to meet these requirements then each of five additional samples are analyzed and the International commission on Microbiological Specifications for Foods (ICMSF)⁵ limits are used as standards. For precooked frozen entrees and vegetables in sauce and breaded precooked fish the constraints are listed in Table 1. The term c indicates the number of samples of the total tested (n) that can exceed a limit m. No sample should exceed an upper value M. This plan allows a number of samples (c) to have counts between the values m and M.

Table 1. Microbiological Limits^a for Precooked Frozen Foods

Item		n ^c	Limit per g		
			c	m	M
Precooked, frozen entree, vegetables	Standard plate count	5	2	10 ⁵	10 ⁶
	Coliform count	5	2	10 ²	10 ⁴
	<i>Escherichia coli</i>	5	2	0	10
Breaded, precooked fish ^b	Standard plate count	5	2	10 ⁶	10 ⁷
	Coliform count	5	2	10 ²	10 ⁴
	<i>Escherichia coli</i>	5	2	0	10

^aBased on ICMSF (1974)

^bThe breaded fish is purchased breaded and raw and is not thoroughly processed at the facility.

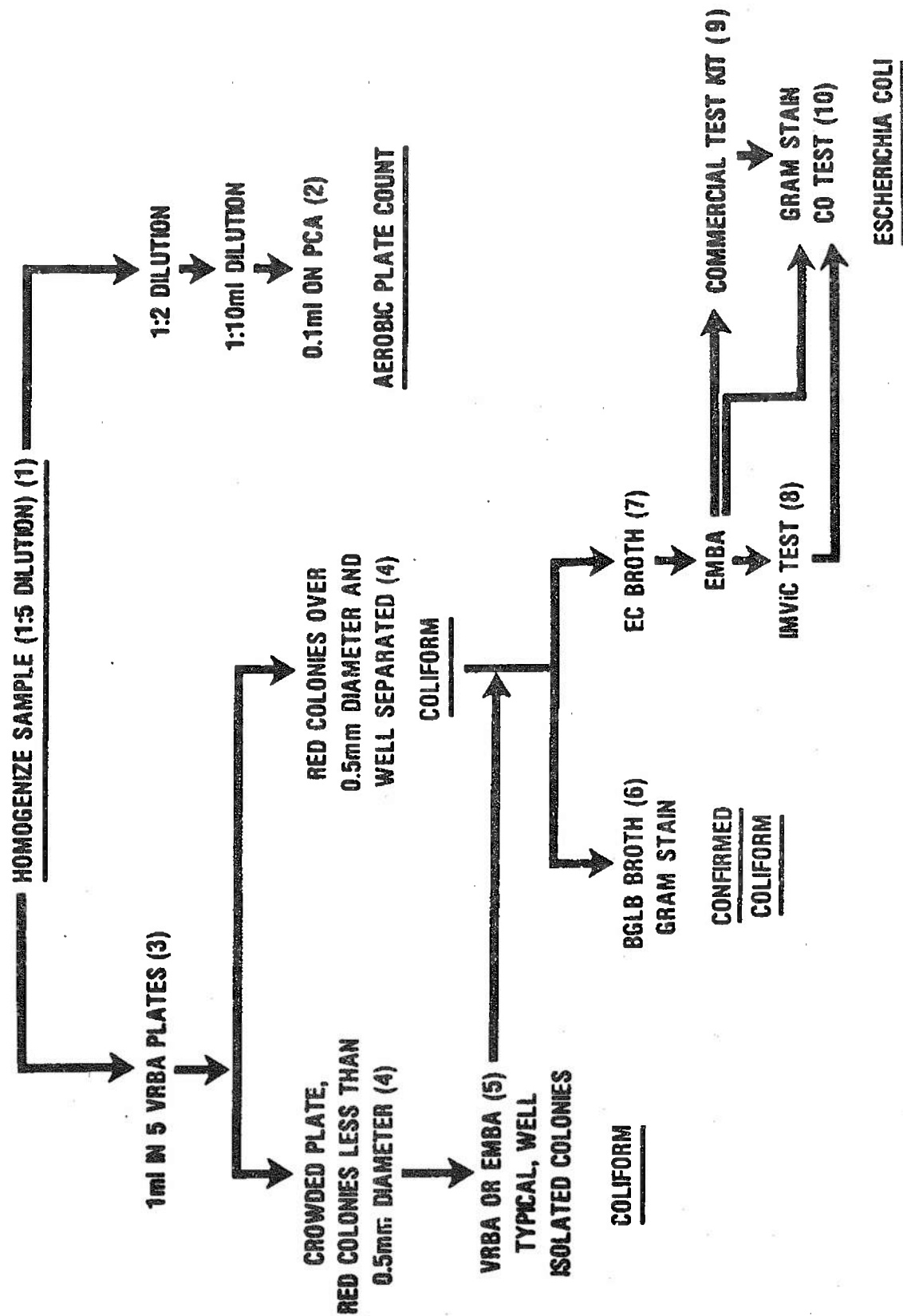
^cn=number of samples to be analyzed; c=number of samples which can exceed a count m. No sample should exceed a count M.

³Ibid.

⁴Ibid.

⁵International Commission on Microbiological Specifications for Foods. *Microorganisms in Foods. 2. Sampling for microbiological analysis: Principles and specific application.* Toronto Univ. Press, Toronto, Canada, 1974.

FIGURE 1. MICROBIOLOGICAL ANALYSIS



II. GOOD MANUFACTURING PRACTICES

A. Raw Materials

1. The QIS, in collaboration with the Foil Pack Kitchen Supervisor, will verify acceptable sources of ingredients and also those ingredients that will have to be pretested in II A-2.

2. Ingredients that are processed with either no or minimal thermal processing, and which might result in contributing an excessive microbial burden to the product, should be analyzed by the QIS and used only if microbiologically acceptable.

B. New or modified processing procedures are to be reviewed by the QIS prior to their introduction.

C. Each product will have appropriate processing parameters which must be monitored. This will be accomplished with the use of a checklist compiled by the QIS and the Foil Pack Kitchen Supervisor.

1. The environmental and processing elements to be monitored are listed in Table 2.

D. Processing Temperatures

1. The temperatures given below are the minimal temperatures required for microbiological safety and for conformance with SACR 146-1⁶. Due to processing requirements the actual cooking temperature employed may exceed those listed below. Unless specifically noted, in accordance with AR 40-5⁷, refrigeration temperatures should not exceed 45°F (7°C).

2. Temperatures should be measured with calibrated thermometers, accurate to $\pm 3^\circ\text{F}$ (2°C). When the temperature of items such as roasts or meat loaf are being measured in the oven, then at least two items in each pan, including the largest, are to be tested.

a. Roasts

(1) Beef — not less than 145°F (63°C) or its equivalent.

(2) Pork — not less than 150°F (66°C).

⁶See reference 1.

⁷Army Regulation AR 40-5, Medical Services, Health and Environment Chapter 6, Food Service, 25 September 1974, p 6-0.

**Table 2. Specific and General Monitoring Elements
Used in Surveillance**

1. Processing elements to monitor in the Quality Assurance Program.

Code	Element to be monitored
a	Baking temperature
b	Cooking temperature (oven)
c	Steamer temperature
d	Temperature in kettle or tilt fryer
e	Frying oil temperature
f	Rate of cooling
g	Sanitation of slicing machine
h	Microbiological analysis prior to use

2. Monitoring elements assigned to specific menu items.

Menu item number		Monitoring task
22,29,40 41,42,90	Portioned prior to cooking in the oven	b
23,24,32	Cooked in oven, sliced and portioned chilled, hot gravy added	a,f,g
26	Commercial, precooked sliced and portioned	g,h
28	Commercial, breaded	e
30,33,35 37,45,46 48,49,91	These items are usually prepared and cooked in a kettle	d
31	Steamed, fried	c,e
44,53,54 55,57,58	Vegetables and rice	c
70,72,73	Cakes	b
74,76	Pies	d

**Table 2. Specific and General Monitoring Elements
Used in Surveillance (cont'd)**

3. In addition to the above monitoring elements, for specific food items the QAP will require more general monitoring surveillance on:

- The proper use of disposable gloves
 - Portioning temperature
 - Final chill temperature
 - Sanitation
 - Storage of ingredients
 - Thawing of frozen ingredients
 - Proper functioning of processing equipment
 - Personal hygiene
-

(3) Turkey loaves — not less than 165°F (74°C).

(4) After cooking, roasts should be cooled to 45°F (7°C) or below as rapidly as possible.

(5) The slicing operation should be conducted at 45–50°F (7–10°C) and, if not completed within two hours, the slicer should be resanitized. The sliced product should be stored in this temperature range until portioned and frozen within three hours of slicing.

b. Meat Loaf

(1) Should be cooked to not less than 165°F (74°C).

c. Gravies and Sauces

(1) Should be cooked to not less than 160°F (71°C) and portioned above 150°F (66°C).

d. Chicken

(1) Thawing should be conducted at 45°F (7°C) or below.

(2) Raw chicken should be cooked either by steam or in an oven to 165°F (74°C). For BBQ chicken, the cooked chicken should be maintained above 140°F (60°C) while being combined with BBQ sauce and frozen within two hours. For processing fried chicken, the cooked product should be chilled to 45°F (7°C) prior to breading.

e. Toppings — Beef Pot Pie

(1) The topping should be browned at not less than 150°F (66°C).

f. Vegetables

(1) Vegetables should be cooked to a temperature of 155°F (68°C).

(2) Processed items waiting to be packaged and frozen should not be exposed to temperatures above 50°F (10°C) for more than one hour.

E. Gloves will be worn by personnel who are performing the following operations:

1. Portioning items by hand.
2. Slicing roasts.
3. Handling breading.
4. Portioning dessert toppings.
5. Portioning cooked and chilled pasta products where the product is handled without utensils.
6. Any exception to the above use of gloves can only be obtained from the QIS and the Foil Pack Kitchen Supervisor.

F. Sanitation and Personal Hygiene

1. Refer to SACR 146-1⁸, AFR 163-8⁹, AR 40-5¹⁰.

III. TECHNICAL SENSORY PANEL

A. The QIS will be responsible for the preparation of samples, selecting participants, conducting the evaluation panel, collecting and summarizing data, and communicating the conclusions drawn from the data to responsible personnel in the Food Service and Veterinary Sections.

B. In addition to the QIS, the panel will consist of at least:

⁸See reference 1.

⁹Department of the Air Force AFM 163-8, Food Service Sanitation, 23 February 1972.

¹⁰See reference 6.

1. One Veterinary representative.
2. Three Foil Pack Facility personnel including the superintendent.
3. One Food Service representative.

C. Recommendations of the sensory panel should be employed as a guide for modifying menu items or for correcting problems in formulation or in processing.

CONCLUSIONS

A comprehensive QAP, designed to be conducted by a limited number of personnel has been tested and found to be efficient and effective. This program does not increase the requirement for microbiological analysis but does require considerably more monitoring activity and active participation and involvement by production personnel. In practice the QAP has eliminated a number of problem areas, such as the use of inferior ingredients, and has, by broadening the responsibility for monitoring to include production supervisors, improved the uniformity of production temperatures.

RECOMMENDATIONS

1. Review the microbiological constraints and adapt either those of the ICMSF or equivalent values.
2. Substitute a most probable number technique for the violet red bile agar plates and substitute a faecal coliform count for the requirement for identifying *E. coli*.
3. Allow the Central Production Facility to use more discretion in purchasing ingredients so that the procuring of ingredients having high microbial counts can be minimized or eliminated.

SUPPLEMENTAL REFERENCES

APHA, Compendium of Methods for the Microbiological Examination of Foods. Washington, DC.

Bacterial Analytical Manual, Bureau of Foods, Division of Microbiology, which is distributed by the Food and Drug Administration and also included in the publication, Official Methods of the Association of Official Analytical Chemists, AOAC, Washington, DC.

International Commission on Microbiological Specifications of Foods (ICMSF), Microorganisms in Foods. 1. Their significance and methods of enumeration. Univ. Toronto Press, Toronto, Canada, 1978.

APPENDIX A

Notes for the Procedures for Analyzing Food Samples

APPENDIX A

While this QAP is designed to conform to the requirements of SAC regulation 146-1¹¹ which requires a composite sample it does depart from it in having a verification requirement (Procedures, IB, 2b(2), Table 1). The regulation SAC 146-1¹² suggests that individual sample unit analysis may be performed on lots to aid in locating the cause of high counts. In this QAP, verification is considered essential and the ICMSF (1974)¹³ concept is adapted. Although the ICMSF plan requires the analysis of more samples it does allow a small number of samples to contain higher bioburdens and will tolerate the presence of a number of *Escherichia coli* organisms.

The following notes correspond to numbers in the parenthesis in Figure 1.

NOTES

1. Weigh 10 g of each of five foil samples into a stomacher bag or blender jar. Add 200 ml of diluent (stock solution: KH_2PO_4 —34 g; distilled water—500 g; adjust to pH 7.2 with NaOH; adjust volume to 1000 ml with distilled water and sterilize at 121°C—15 min; store refrigerated. For preparing diluent add 1.25 ml of stock solution to 1000 ml of distilled water and sterilize at 121°C—15 min) and homogenize (1:5).

2. Subsequent 1:2 and 1:10 dilutions results in a 1:100 dilution and a 0.1 ml aliquot of this dilution on the plate count agar (PCA) plate will result in a 1:1000 dilution of colony forming units (CFU) per gram of food. If over 100 CFU's are present on the PCA plate after incubation for 24—48 hours at 35°C then the food contains over 100,000 CFU/g and should be rejected.

3. Violet red bile agar (VRBA). Incubate plates at 35°C \pm 1°C for 24 hours.

4. If large numbers of other organisms are present, then the coliform colonies will be less than 0.5 mm in diameter. Certain non-coliform organisms can form small red colonies.

5. Unless the colony to be selected is well isolated, possible contaminants should be eliminated by streaking the colony on VRBA or eosine methylene blue agar (EMBA), incubating the plates at 35°C—24 hours, and selecting a well isolated colony for verification.

The number of colonies to be selected for verification as a coliform or *Escherichia coli* depends upon the number of presumptive colonies present.

¹¹ See reference 1.

¹² See reference 1.

¹³ See reference 5.

Number of presumptive colonies	Number of colonies to select
>51	10
11-50	7
5-10	5
≤4	All

6. The use of brilliant green lactose bile (BGLB) broth (2%) for the confirmation of a coliform organism is optional and is not normally required when VRBA plates are used — but unless gas is produced by the organism it will not conform to the definition "the coliform group of bacteria comprises all aerobic and facultatively anaerobic, Gram-negative, nonspore-forming rods able to ferment lactose with the production of acid and gas at 32°C within 48 hours."¹⁴ The use of 32°C is not critical and 35°C is recommended, but taxonomically the presence of Gram-negative rods which produce gas from lactose is necessary for identification. In instances where over 100 presumptive coliforms are present on VRBA, a number of isolates should be inoculated into BGLB and Gram stained for verification prior to the condemnation of a production lot.

7. EC broth should be inoculated and incubated at 45.5°C±0.05°C and examined for the presence of gas at 24 and 48 hours.

8. Use conventional IMViC tests or an IMViC plate as described by Powers and Latt.¹⁵

9. This is an optional method. These kits will identify specific organisms which are members of the Enterobacteriaceae, including *E. coli*, but cannot designate an isolate as a "coliform" or as a "faecal coliform" organism.

10. The inoculum for the cytochrome oxidase (CO) test can be taken from either the EMBA or the IMViC plates.

11. If a composite sample fails to meet SAC requirements, then a verification analysis of five samples, and the use of Table 1 is required. The analytical techniques to be used is that described in this Appendix and in Figure 1.

¹⁴Marth, E.H., Standard Methods for the Examination of Dairy Products, 14th Ed., APHA, Washington, DC, 1978.

¹⁵E.M. Powers and T.G. Latt, Rapid Enumeration and Identification of Stressed Fecal Coliforms. J. Food Protection, 42, 342-345, 1979.